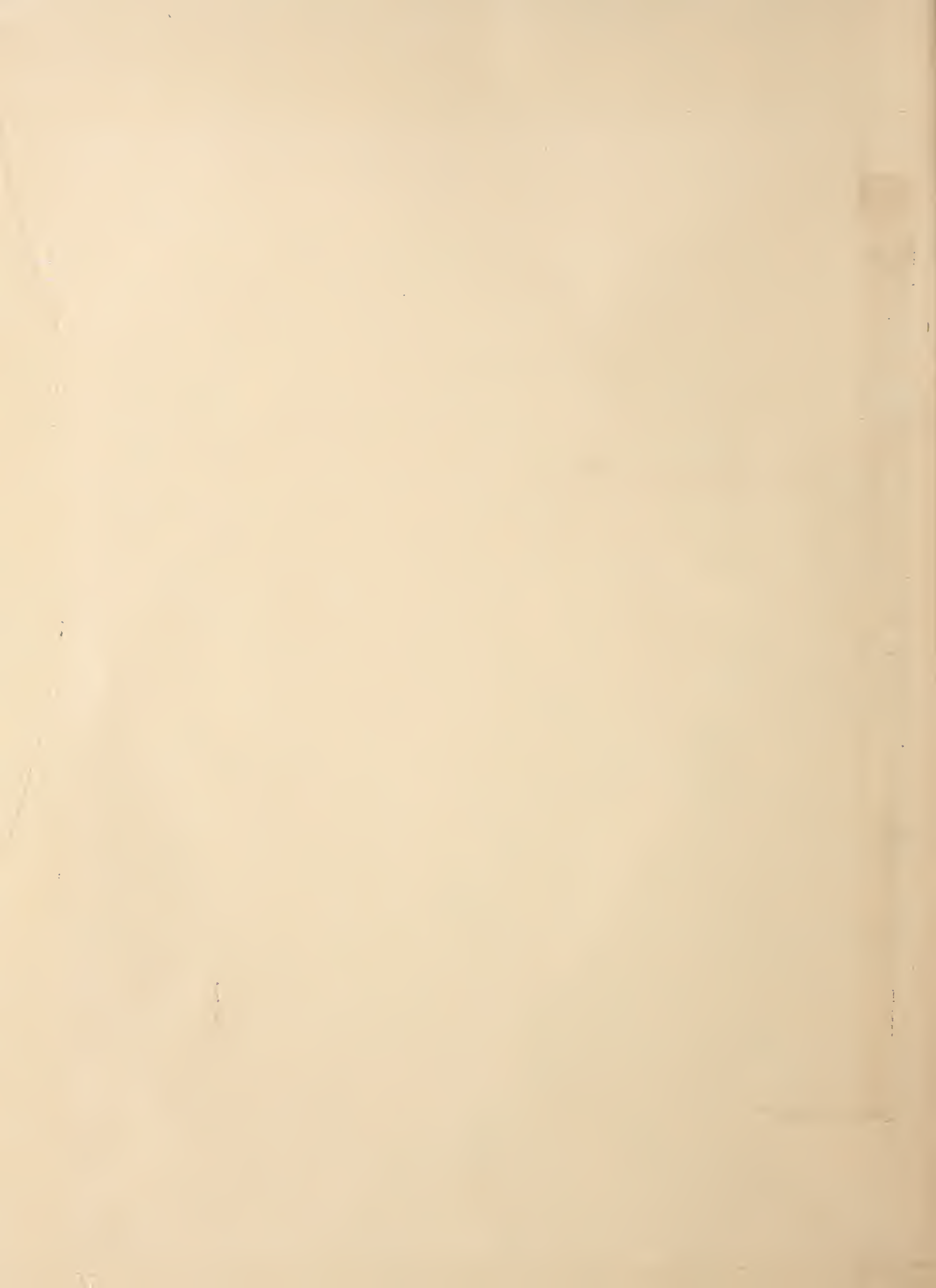
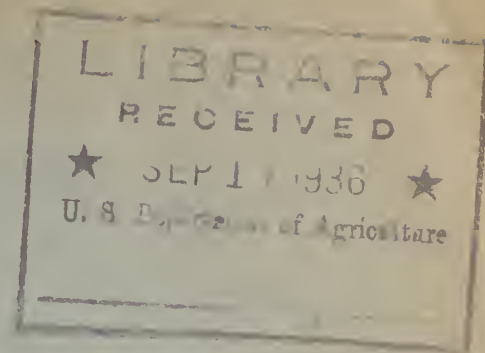


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UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
WASHINGTON, D. C.
H. H. BENNETT, CHIEF



ADVANCE REPORT
on the
SEDIMENTATION SURVEY OF LAKE SAPULPA
SAPULPA, OKLAHOMA

December 5, 1935 to January 10, 1936

by

Louis M. Glymph, Jr. and Victor H. Jones

Division of Research
Section of Hydrodynamic Studies
SCS-SS-7
August, 1936

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GENERAL INFORMATION

Location: State: Oklahoma.

County: Creek. Sections 30 and 31, Sapulpa Township (T. 18 N., R. 11 E.), and section 36, Kellyville Township (T. 18 N., R. 10 E.).

Distance and direction from nearest city: Five miles west of Sapulpa, Okla.

Drainage and backwater: Euchee Creek.

Ownership: The city of Sapulpa.

Purpose served: Municipal water supply.

Description of dam: The water of Lake Sapulpa is retained by an earthen dam built across the valley flat of Euchee Creek. From the steep sandstone bluff to which the south end is anchored, the dam extends 914 feet north in a straight line to the spillway. From the north end of the spillway it extends approximately northwest 258 feet to an anchorage on a shoulder of sandstone. The elevation of the top of the dam is 730 feet above sea level, and its maximum height above the former stream channel is 40 feet. A core wall of concrete one foot thick at the top reinforces the dam for a distance of 120 feet north from the south end, and extends across the old stream channel. Across the top the dam is 12 feet wide. It is covered with thick grass and faced with riprap of sandstone blocks to a height of one foot above crest level. The upstream face of the dam has a $2\frac{1}{2}$ to 1 slope, and the downstream slope is $1\frac{1}{2}$ to 1.

The concrete spillway has a length of 148 feet and a crest elevation of 723 feet above sea level, 7 feet lower than the top of the dam. The original spillway elevation of 720 feet was raised 3 feet by a concrete extension built in 1921.

Date of completion: Original dam completed in 1913. Spillway raised 3 feet in 1921. Average date of survey, December 1935. Age to date of survey, 22.5 years.

Length of lake: Original: 2.72 miles
 Present : 2.72 miles
 Reduction: None

<u>Area of lake at crest stage:</u>	Original	94.05 acres
	Present	91.44 acres
	Reduction	2.61 acres

Storage capacity at crest level:

	<u>Acre-feet</u>	<u>Gallons</u>
Original.....	1,094	356,480,000
Present.....	911	296,849,000
Loss by silting.....	183	59,630,000

General character of reservoir basin: The impounded water occupies a segment of the channel and adjacent bottom lands of Euchee Creek Valley. From the dam the lake extends generally westward in a crudely S-shaped portion of the valley. One tributary channel on the north side and two on the south side form minor bays of the lake. In conformation with the original configuration of the valley the greatest depths of water are near the southern shore, where the lake is bordered by bluffs and steep slopes of sandstone. The northern margin is bordered by a low alluvial terrace. The width of the lake at crest level is 1,130 feet at the dam and 850 feet a quarter of a mile above the dam.

A feature of Lake Sapulpa is the unusual length of ponded channel above the main body of the lake. Measured along Euchee Creek channel the backwater extends 1 3/4 miles upstream above the lake proper. The abrupt constriction of old Euchee Creek channel at range 029-031 is due to a resistant sandstone stratum extending across the valley at that locality. Just below range 040-041 is a similar occurrence of which the small sandstone island is a conspicuous part. As a result, the segment between the two ranges mentioned above narrows abruptly at both ends, and has received an unusually heavy deposit of silt and very fine sand. By extensive boring and spudding on and off the ranges in this portion of the lake, it was concluded in the field that a series of rapids and low falls occurred in the original channel between ranges 025-026 and 040-041. Above range 040-041, however, no such rapids occurred, and the channel gradient was much lower for some distance upstream. Thus the ponded backwater extends into an unusually long reach of channel above the main lake.

Area of watershed: 8.72 square miles or 5,579 acres.

General character of watershed: Most of the watershed of Lake Sapulpa consists of moderate to steep slopes and has relatively little flat area on the divides. The stage of erosional development of the area is therefore that of maturity. From a maximum elevation of 1,000 feet above sea level along ridges at the head of the drainage area the slopes decline eastward to an altitude of 723 feet, the elevation of the lake. The maximum

relief is, therefore, nearly 300 feet, and slopes of 150 feet within a horizontal distance of half a mile are typical. An important feature of the main valley is an alluvial terrace which occurs chiefly north of the lake and lies 6 to 12 feet above the lake level. The stratigraphy of the region is known chiefly from the logs of many oil wells, since the Sapulpa district is one of the oldest large petroleum-producing areas in Oklahoma. The following section of local Pennsylvanian rocks was compiled from the geological map of Oklahoma and records of oil wells drilled by the Gypsy Oil Company of Tulsa.

	Pawhuska formation
	Elgin sandstone
	Negalongey formation
	Ochelata formation
	(Dewey limestone
Drum	(Nellie Bly formation
Group	(<u>Hogshooter limestone</u> - a horizon marker
	<u>Coffeyville shale and sandstone</u>
	<u>Checkerboard limestone</u> - a horizon marker

A thickness of at least 500 feet of strata between the Checkerboard limestone and the Dewey limestone is exposed within the drainage area of Lake Sapulpa. Of chief importance to this report is the fact that approximately 50 percent of the exposed strata is arenaceous shale. The thin limestones are insignificant in volume and area although important as horizon markers.

A typical example of the strata is exposed in a 40-foot bluff of sandstone at the south end of the Lake Sapulpa dam. The upper 20 feet consists of cross-bedded, fine-grained sandstone fairly well cemented, and case-hardened with silica on exposed surfaces. It contains about 25 percent of silt and clay-size particles and a small percentage of muscovite. It is light gray on fresh surfaces and becomes buff or reddish upon oxidation. The lower 20 feet of sandstone is more massive and regularly bedded but similar in composition to the upper strata.

Throughout the watershed the strata have a prevailing westerly dip. The major strike of the region is approximately N.25°E. and the formations are inclined westward at angles ranging from 3° to 10°. Differential erosion of resistant and non-resistant strata has produced a series of eastward-facing ridges and valleys roughly parallel to each other. One such ridge extends east of north from Sapulpa to Tulsa, and another one lies parallel to it five miles farther west. The Lake Sapulpa watershed is on the eastern slope of the latter ridge. From the lake the water of Euchee Creek flows eastward through two small channel reservoirs and joins Rock Creek 3 miles east of Lake Sapulpa. About 3 miles southeast from the junction, Rock Creek flows through a gap in the eastern ridge and breaks up into small distributaries on a broad, low plain near Kiefer. During flood seasons the high water enters a branch of Duck Creek and thence flows into the Arkansas River.



Soils of the area are generally thin and poor. No comprehensive information on soil types is now available, but a soil map and report on Creek County by the Bureau of Chemistry and Soils, United States Department of Agriculture, are now in preparation. On the fragmentary upland areas and the predominantly rocky slopes the soil thickness ranges from 1 to 6 inches. On considerable areas of the steeper slopes a well developed soil is absent. Only insignificant mineralogical changes have accompanied weathering and soil formation from the country rock. Grains of silica from sandstones and shales have participated without change. Iron-bearing minerals in the clays and silts have been oxidized. The resulting soil is a very sandy gray to dark-gray loam, its color depending somewhat upon the content of humus. The subsoil is almost invariable red.

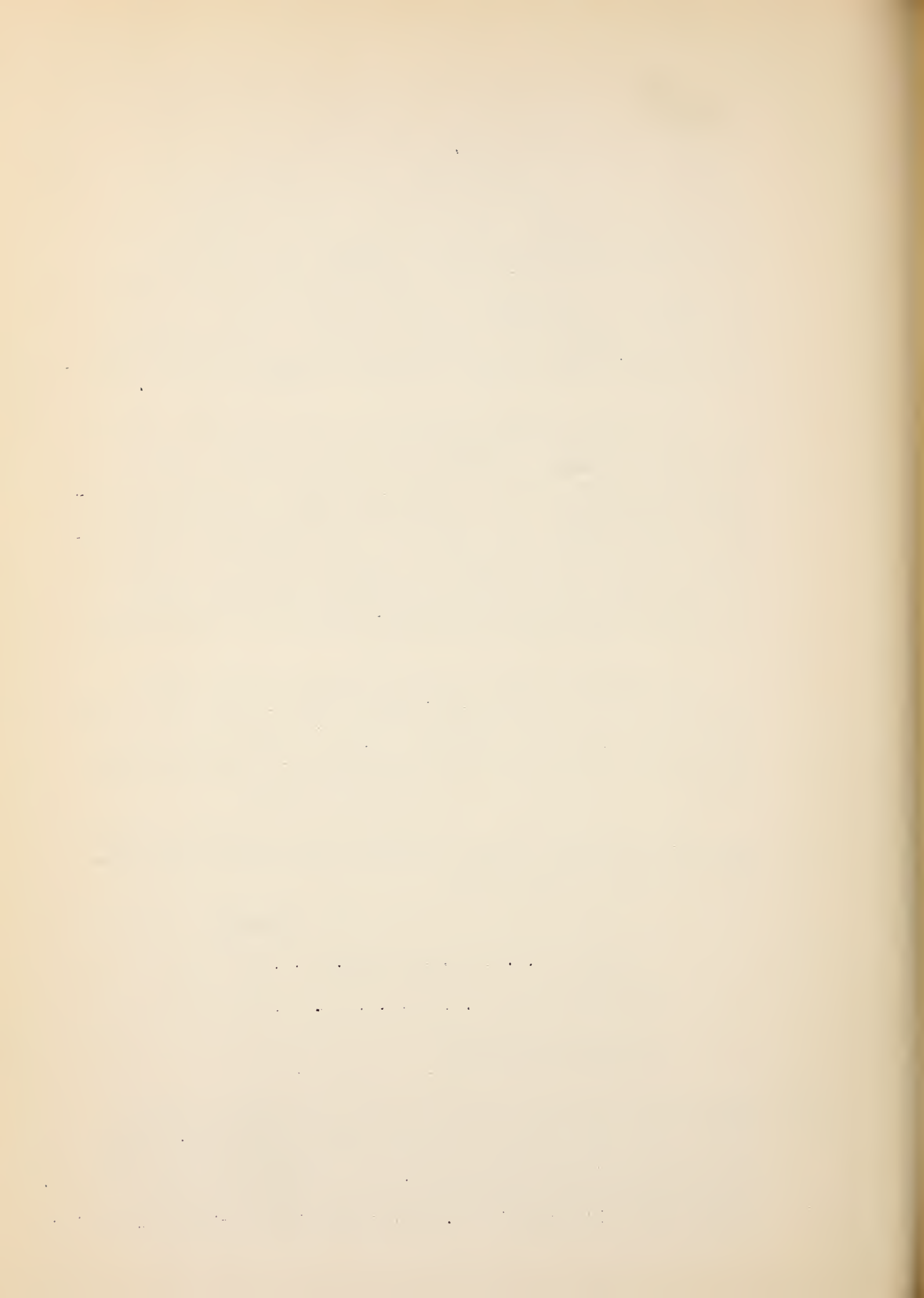
In the main valley a thicker and more productive soil has been developed upon recent alluvial deposits and upon a Pleistocene terrace of considerable extent. The terrace consists of 6 to 12 feet of sandy silt which is inconspicuously stratified. It is an alluvial deposit of Pleistocene age and its surface lies a few feet above the present channel. The material of the terrace ranges from medium-textured sand to clay with silt predominating, and is composed of quartz with minor amounts of muscovite and iron oxides. The deposit has a prevailing orange color and is very compact, although no cementation has occurred.

The sediment carried into Lake Sapulpa has two chief sources, (1) the easily eroded terrace silts in the main valley, and (2) soil derived by vigorous run-off from slopes of the watershed. The terrace silts are easily available at and near the head of the lake, and large quantities are eroded from the banks by seasonal flood waters of Euchee Creek.

No reliable figures pertaining to land use in the watershed are available, but the following estimates were made during the course of the survey.

	<u>Percent</u>
Forests.	20
Cultivated	10
Scanty pasture with scattered scrub oak.	70

Nearly all cultivated areas are in the main valley of Euchee Creek. The chief crops are cotton, corn, sorghum, and garden vegetables. The uncultivated portion of the valley is heavily forested with oaks, sycamore, hickory, walnut, and other trees, chiefly hardwoods. Upon some slopes and small upland areas stunted oaks predominate. A rather thin prairie grass retains



a foothold upon most of the rocky slopes of the outer margin of the drainage area. Oil leases have been let in some localities, and the land surrounding the wells is not utilized for any other purpose.

According to the Reconnaissance Erosion Survey map 1/ of Oklahoma the Lake Sapulpa drainage area is divided into two erosional classes. The valley flat is an area of little erosion, while all slopes are subject to severe sheet erosion. Destructive gullies of the area are few and small. It is the writers' opinion that original soils on all the sandstone slopes were thin and poor, and suitable only for moderate grazing use.

Mean annual rainfall: 34 inches.

Draft on reservoir:

Maximum during summer months..... 1,000,000 gallons per day.

Minimum during winter months..... 500,000 gallons per day.

HISTORY OF SURVEY

The survey of Lake Sapulpa was made by the Central Reservoir Party, Section of Hydrodynamic Studies, Division of Research, during the period Dec. 5, 1935 to Jan. 10, 1936. Members of the party were L. M. Glymph, Jr., Chief; V. H. Jones, Assistant Chief; E. M. Flaxman; W. G. Shannon; Glen Petrick; O. D. Price; and H. L. Fischer.

Field work was begun by chaining a 1,000-foot base line along the center of the dam. From this line 13 additional points were established by plane-table triangulation to form a system of horizontal control.

A map of the lake with a 5-foot contour interval was made before the dam was built. No further mapping was done, however, following the 3-foot increase in spillway elevation in 1923. The original map was available but could serve only as a guide for field work. Approximately 10.5 miles of shore line were mapped during this survey. Mapping was done by plane-table and telescopic alidade on a scale of one inch to 100 feet. A total of 50 range lines was established to divide the surface area of Lake Sapulpa into segments of which individual volumes could be calculated. Water depth measurements were made along ranges with the standard sounding line, and the standard silt sampler, or spud, was used over a large portion of the lake. At certain places in the original channel, however, and in the delta area, it was necessary to substitute a soil auger with an adjustable stem of 5-foot lengths of gas pipe in order to measure the greatest thicknesses of sediment.

1/ Reconnaissance Erosion Survey of Oklahoma (map) U. S. Dept. of Agriculture, Soil Conservation Service. Scale 1/500,000, 1934.

ACKNOWLEDGEMENTS

The use of city boat equipment, early maps of the lake, and material for monuments was made possible by Fred M. Boone, City Manager of Sapulpa, and H. D. Pickett, City Water Superintendent. Dr. L. R. Laudon, of Tulsa University, kindly loaned topographic maps of the region for use during the survey. Dr. Max Littlefield, of the Gypsy Oil Company of Tulsa, furnished information on stratigraphy and structure of the Lake Sapulpa region.

VOLUME, DISTRIBUTION, AND CHARACTER OF SEDIMENT

Relation of gradient to distribution of sediment: A study of gradients throughout the lake basin, as determined by the range work, reveals a definite relationship between original slopes and the location of the heaviest silt accumulation. As a result of differences in resistance to erosion of the strata encountered by Eucheé Creek, the channel within the lake area falls into three divisions, each having a different gradient. All measurements of gradient were made along the thalweg, or main channel, of the stream course. For convenience the three divisions are designated by the symbols R, S, and T.

Division R extends from the dam to range 025-026, and includes the major portion of the main lake. It includes segments numbered from 1 through 19, and has a total length of 4,500 feet. Its gradient before construction of the dam was 13 feet per mile. Silt deposition has increased the gradient of this division to 21.5 feet per mile.

Division S has a length of 1,300 feet from range 025-026 to the lower edge of the delta top-set beds at range 040-041. It includes segments 19, 20, 24, 25, 26, and possessed a much steeper original average gradient than that of any other portion of the lake. Segment 20 had a slope of 39 feet per mile and probably included a reach of low falls and rapids. As a whole, division S had an average gradient of 27 feet per mile. Such heavy deposition of sediment has occurred in this division that the gradient on the present silt surface is now 10 feet per mile in the reverse direction (upstream).

Division T includes the main delta and all of the ponded channel. Its length is 8,960 feet, but the aggregate surface area and volume of water are small. The narrow, sinuous delta occupies channel areas in the lower 2,000-foot reach of the ponded channel. At no place does the width of the delta exceed 300 feet. The gradient of the ponded channel bottom has been reduced from 11 feet per mile to 8.6 feet per mile by deposition of silt and sand in the channel between ranges 040-041 and 057-058.

Distribution of sediment: An examination of sediment thicknesses in the lake shows a gradual increase in silt depth from the dam upstream to range 025-026, 1,200 feet below the delta. Near the dam on range 01-02 a maximum thickness of 3 feet of silt was measured in the old channel. At the deepest point on range 025-026 the maximum thickness is 12.5 feet. This is approximately the position of the pre-lake fall or rapids. Above range 025-026, in the constricted bay comprising segments

24, 25, and 26, the deposition of heavy bottom-set beds has decreased the volume of water storage by approximately 60 percent.

The delta is long and irregularly sinuous. Its position and configuration are the result of pre-existing basin-like areas of channel and wider areas at bends. Its maximum width is about 275 feet and its length is 1,200 feet. In a narrow stretch at range 044-046 flood-season currents have maintained a channel through the delta and have prevented deposition of top-set beds. The main areas of top-set beds lie just above and below this range.

From range 057-058 at the head of the delta, the sediment in the channel decreases in thickness upstream for 1,200 feet and is entirely absent at range 070-071. The uppermost mile of the ponded channel is subject to stream action in which erosion is predominant, so that only insignificant amounts of fine sediment have accumulated at bends. In Lake Sapulpa the zone of heaviest deposition extends from the upper portion of the delta entirely through the restricted bay previously described ^{1/} to the locality of range 025-026. Three divisions of this zone may be recognized: (1) along the channel just above the bay, (2) in the bay itself, and (3) just below the narrow mouth of the bay where the water depth increases rapidly and the inflowing currents encounter the retarding influence of the main lake. From this zone of heaviest deposition the silt blanket diminishes in thickness both upstream and downstream. Tributary branches of the lake contain relatively small amounts of sediment.

Character of sediment: The bulk of the sediment in the main body of Lake Sapulpa consists of blue-black, unctuous silt which adheres strongly to any object when wet. It appears to contain a high percentage of clay particles and may have some petroliferous constituents. At least 12 oil wells have been drilled and pumped extensively in the drainage area near the lake. Of these only 3 are now in production. The sediment is noncalcareous.

Zones of sandy silt were observed opposite the tributary arms in segments 5, 11, and 21. Furthermore, the bulk of the delta sediment in segments 27, 28, 29, 34, and 35 consists of fine and very fine sand. This distribution is the result of the decrease in velocity of inflowing currents as the water approaches and enters the wider part of the lake. The sandy material is deposited in and near the delta, and much silt and clay is carried farther into the lake. A considerable proportion of the finest sediment is carried through the lake and over the spillway. Even during periods of little rainfall the lake water is somewhat turbid. Large quantities of herbaceous material have been deposited in the delta, and were penetrated frequently by the auger during the survey. The areas of above-crest deposition now support a dense growth of willows.

Pre-lake sediments: In old channels beneath present lake silts the spud penetrated sand or gravel consisting of sandstone fragments. Over the shallower flat areas the dark, sandy, humus soil of the valley

^{1/} See page 5.

was encountered beneath lake silts. In the delta areas a thick stratum of leaves and twigs was often encountered beneath the silts. This sub-silt vegetal stratum contains larger pieces of bark, larger twigs and branches, and is more difficult to penetrate than the higher strata of leaves occurring at several levels in the delta deposit. Many of the borings through the delta entered a coarser, more deeply oxidized sand which was interpreted as pre-lake channel sediment of Euclee Creek. In some borings the auger encountered fine sandstone gravel beneath the delta deposit.

SUMMARY STATEMENT

1. Sediment sources are chiefly: (1) terrace deposits of sand and silt in Euclee Creek Valley, and (2) silt and sand from soil erosion of unprotected slopes in the watershed. The annual accumulation in the reservoir is equal to 62.13 cubic feet per acre for the watershed as a whole.

2. The zone of heaviest deposition, in and near the delta region, is determined by the constricted bay just below it and the ponding of the water over an originally steep gradient. Definite sorting action occurs to deposit sand predominantly in the delta and silt predominantly in the lower lake. The ponded backwater extends 1 mile into the channel, where erosion predominates over deposition.

3. Gradient changes have been occasioned by deposition of sediment in the submerged main channel as follows: (1) the gradient of the lower lake has been increased; (2) the original steep gradient between ranges 025-026 and 040-041 has been reversed by heavy silt deposition as far below the constriction as range 025-026; (3) deposition at the delta has decreased the original gradient of the ponded channel above.

The following tabulation is a statistical summary of data relating to Lake Sapulpa, Sapulpa, Oklahoma.

	<u>Quantity</u>	<u>Unit</u>
<u>Age:</u> 1/	22.5	Years
<u>Watershed:</u>		
Total area.....	8.72	Square miles
	5,759.2	Acres
<u>Reservoir:</u>		
Original area at crest stage.....	94.05	Acres
Present area at crest stage.....	91.44	Acres
Original storage capacity.....	1,094.00	Acre-feet
Present storage capacity.....	911.00	Acre-feet
Original storage per square mile of drainage area....	125.54	Acre-feet
Present storage per square mile of drainage area....	104.54	Acre-feet
<u>Sedimentation:</u>		
Delta deposits).....	Not measured separately	
Bottom-set beds)		
Total sediment.....	183.00	Acre-feet
Accumulation per year average.....	8.10	Acre-feet
Accumulation per year per 100 square miles		
drainage area.....	93.27	Acre-feet
Accumulation per year per acre of drainage area.....	63.48	Cubic feet
Or, assuming average weight of 1 cubic foot of silt		
is 100 pounds.....	3.17	Tons
<u>Depletion of storage:</u>		
Loss of original capacity per year.....	0.74	Percent
Loss of original capacity to date of survey.....	16.72	Percent

1/ Date storage began: 1913. Date of this survey: December 1935.

